IES Newsletter

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Editor's Comment

As observers of the out-of-doors, you recognize dozens upon dozens of interactions among animals and plants, animals and animals, and animals, plants and their inanimate surroundings. Hummingbirds visit your *Monarda.* Locust leafminer beetles skeletonize the black locust trees you pass on your way to work. Ants cultivate the aphids that suck life from your garden plants. Lichens – symbiotic partnerships between a fungus and a photosynthetic organism – grow on a rock in your backyard and, decades to centuries after you've stopped watching, will have broken the rock down into soil particles.

For ecologists, understanding these kinds of relationships is their life's work. These scientists uncover new relationships where, prior to their investigations, no one would have suspected they existed. In this issue of the newsletter, when you read about ecosystem engineering at work on Argentinian mudflats, and how biodiversity may have a direct connection to Lyme disease, you, too, may start watching for the more subtle connections in your ecosystem.

The *IES Newsletter* is published by the Institute of Ecosystem Studies, located at the Mary Flagler Cary Arboretum in Millbrook, New York.

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Ecosystem Engineers Modify the Mudflats

What kind of impact can a small crab have on a large seashore? According to Jorge Gutiérrez: a considerable one.

Gutiérrez, a doctoral student at the Universidad Nacional de Mar del Plata, Argentina, is studying the interactions between burrowing crabs and stout razor clams on mudflats along the southeastern coast of Argentina. He is finding that these creatures are "ecosystem engineers" (see box, page 3): they physically modify their intertidal environment and thereby affect many other species.

Chamagnathus granulata finds shelter by burrowing into mud. In so doing, this crab — whose carapace, or shell, is a mere 4 centimeters (1.5 inches) across — changes the character of the sediment by stirring it up so that the finer grains are suspended, then deposited on the surface, and finally dispersed by currents. For animals that feed on sediment, fine grains have a higher nutrient content and are more easily digested than larger particles. The environment created by the burrowing crab is therefore attractive to sediment feeders. Clams fall into this category, and *Tagelus plebeius,* the stout razor clam (6.5 - 8 cm, or 2.5 - 3 in.), thrives where there are high densities of burrowing crabs.

MARIA SAMPEDRO

Jorge Gutiérrez and thousands of stout razor clam shells, on a mudflat in Mar Chiuquita lagoon on the coast of southeastern Argentina.

Clams feed by drawing water in through a tube called a siphon. Before exiting through a second siphon, the water passes by gills that trap sediment particles. Clams generally burrow into the sediment with only the siphon openings showing, usually in a shallow depression in the mud. Preliminary evidence suggests that when currents are strong, burrowing crabs find adequate food in the sediments swept across and into their burrows, but when currents are weak, they explore the surroundings searching for depressions where organic particles become trapped. These depressions are frequently the ones created by stout razor clams. Gutiérrez has observed that crabs may make even more efficient traps by actually enlarging the depressions where clams reside. And, he notes, a larger pit makes life easier for the clam as well, by increasing the amount of sediment that can collect there.

Under the direction of Dr. Oscar Iribarme, his advisor at the Universidad Nacional de Mar del Plata, Gutiérrez and colleagues are looking beyond what Gutiérrez describes as this mutually positive association between just two organisms. They are studying the role of *Chasmognathus* as a key species in regulating the functioning of southwestern Atlantic estuaries. The burrowing behavior of crabs has an impact on the lives of a number of animals, including sediment-dwellers — polychaetes (bristleworms), nematodes (roundworms) and ostracods (tiny crustaceans) — and shore birds, many of which are migratory species from North America that spend Northern Hemisphere winters in Southern Hemisphere summers. These birds feed on polychaetes. Some are visual predators that stand on the mudflat and wait until they see prey, then run to catch it, while others are random probers that walk more or less aimlessly, sticking their bill into the sediment in the hope of coming up with food. The former are content in the crab beds, while the latter tend to avoid them because the uneven surface impedes progress.

Gutiérrez' earlier research considered the effects of stout razor clam shells, buried during recent geologic time but gradually becoming exposed, on sediments and the benthic communities; after reading a scientific paper by Dr.Clive Jones and IES Adjunct Scientists Drs. John Lawton and Moshe Shachak (see box) on ecosystem engineering, he realized the connections to his own research. His current experiments include introducing burrowing crabs into areas where there are none, then measuring the impact on clams by measuring their body weight.

Gutiérrez had the opportunity to talk with Jones for the first time in Chile last January, when he attended a course for South American graduate students on biodiversity and ecosystem functioning. The course was co-organized by IES Adjunct Scientist Juan Armesto and was taught by Jones and other

continued on page 3

In Search of "Host X"

Not all animals are created equal, at least in their capacity to contribute to the spread of Lyme disease.

It has been established that white-footed mice and, to a slightly lesser extent, eastern chipmunks, are the most important for a variety of reasons: they provide meals for a large number of black-legged ticks; they are the best at obtaining the disease-causing bacteria when bitten by an infected tick and the best at maintaining a viable population of bacteria in their bodies; and they are the most effective at transmitting bacteria to the next black-legged ticks that crawl aboard for their blood meal. Some other vertebrates are much less competent, and the presence of these animals may make a considerable difference both in the prevalence of infected ticks and in the risk of human exposure to Lyme disease.

Many ticks apparently feed on hosts that are less competent than mice and chipmunks. This was discovered by IES ecologists Richard Ostfeld and Kenneth Schmidt who calculated that if black-legged tick larvae — the first of three "biting" stages in the life cycle of the tick (see box) — feed only on white-footed mice and eastern chipmunks, then 86% of nymphs — the second stage — should carry the Lyme disease bacterium. But, at the study sites at IES, only 36% of nymphal ticks were infected. This implies that a relatively large percentage of larval ticks is feeding on other, less competent hosts. Ostfeld and Schmidt call these animals "Host X". Kathleen LoGiudice is trying to discover the identity of the mystery host(s).

During the past two summers, Dr. LoGiudice has been collecting as many individuals of as many species of mammals as she can. Once caught, and before being returned to the point of capture, each animal spends several days in the IES Rearing Facility, in a wire cage over a tray of water. As sated larval ticks drop off, LoGiudice collects them from the water, puts them in individual vials in an incubator, at constant temperature and high humidity, and waits for them to molt. This usually happens from 30 days to two months after the blood meal. By determining the presence of the Lyme disease bacterium in ticks that fed on different mammal species, she learns each species' reservoir competence. From these data, she calculates what contribution each mammal makes to the overall infection prevalence in nymphal ticks.

*Black-legged ticks (*Ixodes scapularis*) have a three-stage, two-year life cycle. At each stage, the tick needs one blood meal. Adult ticks lay eggs in the spring. Transovarial transmission of the Lyme disease bacterium is rare, so virtually all the larvae that hatch from these eggs are incapable of infecting a host. Larvae are barely visible, little larger than the period at the end of this sentence, and are most active from late July to late September, peaking in mid-August; in some years there is a secondary peak from mid-June to early-July. Larvae molt into nymphs during autumn. Nymphs, which are the most apt to transmit the infection to people, are most active from May through August and molt into adults in late summer. Adults, approximately 2 millimeters (0.08 inches) in length before becoming engorged, feed primarily in fall, but adult ticks that don't find a host in fall are active on warm winter days and in spring. After feeding, the adult females lay eggs and the cycle begins again.*

LONNA KELLY

Dr. Kathleen LoGiudice live-traps small mammals to determine their level of "competence" in the transmission of Lyme disease.

From last summer's research, she learned that opossums feed a lot of ticks — she counted as many as 400 per adult — but a mere 1.6% of nymphs collected from opossums are infected with the Lyme disease bacterium. Opossums, therefore, are very incompetent hosts, and, if their populations are high enough, they have the potential to reduce dramatically the spread of the disease. Short-tailed shrews, she found, were a similar case: weighing from 11-22 grams (approximately one-half ounce), they feed, on average, 60 larval ticks at a time (though one shrew made the record books with 524, all attached to the animal's hairless ankles). Since short-tailed shrews also can reach high densities, they have the same potential to "dilute" infectivity.

This summer, LoGiudice has been live-trapping more opossums and short-tailed shrews, as well as masked shrews, gray, red and flying squirrels, raccoons and skunks. She also received permission to collect larvae from deer harvested during August and September by local farmer Elmer Cougler, under a depredation permit, to learn how many ticks deer feed and the deer's efficiency as transmitters of the bacterium.

LoGiudice's findings will add more pieces to the puzzle that is the ecology of zoonotic disease in general and Lyme disease in particular. "When humans have a negative impact on habitats, the last species to disappear tend to be mice and chipmunks — the most competent reservoirs —and when the host community is reduced to only these species, more vectors are infected," says LoGiudice, summarizing evidence not only from her research but also from that of other scientists including Ostfeld, Schmidt and Felicia Keesing (Bard College, Annandale, N.Y.)*. "If we degrade and fragment habitat and decrease biodiversity, we can expect an increase in disease risk."

* * * * *

Kathleen LoGiudice is a postdoctoral associate at the Institute. Dr. Ostfeld was her advisor (together with Dr. Kathleen Scott) when she was completing her doctoral work at Rutgers University, studying the effects of a raccoon parasite on the regionally endangered Allegheny woodrat. With an interest in the connections between wildlife and human disease, she received a postdoctoral appointment to collaborate with Ostfeld and arrived at the Institute in June 2000.

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* In "Biodiversity and Disease Risk: the Case of Lyme Disease", a paper by Drs. Ostfeld and Keesing published in the June 2000 issue of *Conservation Biology*, the authors coined the term "dilution effect", which refers to the observation that "increasing the diversity of hosts reduced disease risk as measured by the infection prevalence of nymphal ticks".

Dr. Likens Elected AIBS President

In January, the American Institute of Biological Sciences' [AIBS] general membership voted IES Director Gene E. Likens president-elect for 2001, which means that in January 2002 he will succeed current president Dr. Judith Weis, professor of biology at Rutgers University, for a one-year term. In this position, he will preside over 82 member professional societies and organizations — at the most recent count — with a collective individual membership of more than 190,000 biologists. Dr. Likens has done long-term, ecosystem research at the Hubbard Brook Ecosystem Study in the White Mountains of New Hampshire since he co-founded it in 1963, and at the Institute of Ecosystem Studies since he founded it 1983. He will remain director of IES while he serves as president, and will stay on the AIBS Board through 2003 as past-president.

Biology includes many disciplines. Basic to applied, molecular to organismal, its branches reach from agronomy to zoology and its broad base incorporates the medical, environmental and agricultural sciences. Some 50 years ago, challenged by such diversity, biologists acted on the need to identify their common goals and interests. The result was an "umbrella organization", AIBS, that provides services, support and a voice for research and education in all the arenas of biology.

Seldom does a day pass without a reminder of the importance of the many specialties within the biological sciences to addressing concerns about the well-being of humans and ecosystems large and small. National and international debates about global warming, biodiversity, bioethics, stem cells, smoking, overuse of antibiotics in medicine and agriculture, particulates and asthma, health and obesity, exercise, urbanization, exotic invasions — the list goes on — are in the news daily.

The biological sciences are central to these debates. How timely to have an ecosystem ecologist with a long-term, big-picture perspective in the president's chair.

* * * * *

The general public is perhaps most aware of AIBS through its monthly publication, *BioScience*, a major scientific journal of very readable articles that is as suited to the reference shelves of high school science departments as to libraries at universities and research institutions such as IES.

Over the past year, four scientific papers co-authored by IES scientists have been published in *BioScience*:

Integrated Approaches to Long-Term Studies of Urban Ecological Systems (July 2000), IES authors: J. Morgan Grove, Steward T.A. Pickett

Acid Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies (March 2001), IES authors: Thomas J. Butler, Gene E. Likens and Kathleen C. Weathers

Human Impact on Erodable Phosphorus and Eutrophication: A Global Perspective (March 2001), IES author: Nina F. Caraco

Reducing Nitrogen Loading to the Gulf of Mexico from the Mississippi River Basin: Strategies to Counter a Persistent Ecological Problem (May 2001), IES author: Peter Groffman.

JILL CADWALLADER

First Prize at the Fair

Butterfly garden, hummingbird garden, ornamental grasses, native plants, xeriscape garden … these were among the ten, themed garden microcosms that drew crowds to the Institute's blue ribbon-display at this year's Dutchess County Fair. The display, designed by Diane Fagergren, perennial gardener II (seen at left, putting the finishing touches on the display just before the fair opened), and Margaret Eyring, horticultural assistant, won first prize in the category of Educational Displays, in recognition not only of its lush plantings but also of its interpretive material.

The troughs that contain the xeriscape plants remain on display on the patio at the Gifford House Visitor and Education Center. All the other plants are growing in Gifford Garden demonstration beds, in the Fern Glen, or in the Greenhouse.

Ecosystem Engineers, *from page 1*

scientific colleagues from the USA, Chile and Argentina. It was at the course that Gutiérrez learned about the Institute of Ecosystem Studies and its opportunities for visiting scientists. With a grant from the Fundación Antorchas, he spent June and July at IES collaborating with Jones and Dr. David Strayer, doing library research, and writing a review article on the engineering effects of mollusks via the production of shells.

We first wrote about ecosystem engineers in the May-June 2000 issue of the IES Newsletter. *From that issue's "Beavers as Engineers":*

Observers of the natural world have long been aware that animals and plants, in the course of doing what they do to survive, can transform ecosystems. Examples range from the oceans, where coral animals build reefs for their own needs and coincidentally create shelter for myriads of other marine organisms, to arid lands, where rock-eating snails in Israel's Negev Desert create soils that enable plants to grow. It was not until very recently, however, that Institute of Ecosystem Studies ecologist Dr. Clive Jones and IES adjunct scientists Prof. John Lawton and Dr. Moshe Shachak proposed a concept that has ecologists looking at ecosystems in a whole new way. This new concept addresses how organisms, from microbes to megafauna and flora, by modifying environments to meet their own needs, affect the availability of resources - sunlight, water, nutrients - to other organisms, thereby determining the fate of these organisms.

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Calendar

CONTINUING EDUCATION

For information, or to request a catalogue, call the Continuing Education office at 845-677-9643 or visit www.ecostudies.org/education/continuing.html.
Upcoming programs include:

Gardening

Oct. 11: **Gardening with Deer**
Oct. 13 (6 sessions): **Soil Science**
Oct. 13: **Integrated Pest Management**
Nov. 17: **Moss Gardens**

Landscape Design

Oct. 10 (4): **Construction II: Site Detailing**
Oct. 13: **Contour Plans**

Biology

Oct. 3 (10): **Introduction to Ecology**
Oct. 21 (4): **Basic Botany**

Workshops

Nov. 10: **Writing What You Love**

SATURDAY ECOLOGY PROGRAM

Come to **free public programs** on the first Saturday of the month. These guided programs begin at 10 a.m. at the Gifford House and last approximately two hours. Pre-registration isn't necessary. If you have questions, call 845-677-7600 ext. 321 for information on upcoming programs:
Oct. 6: **Walk to the Tea House**
Note: Though not rugged, this is a fairly steep walk. The program will last until approximately 12:30 p.m.
Nov. 3: **Winter Tree Identification**
Please wear long pants tucked into socks and sturdy, waterproof shoes for all outdoor programs.

FERN GLEN TOURS

Native Plant Program Assistant Janet Leete leads **free tours of the Fern Glen** on Tuesdays at 11 a.m. and 2 p.m., until mid-October. If you have questions about native ferns and wildflowers but can't make the tour, Leete will be in the Fern Glen each Tuesday from 11 a.m. - 3:30 p.m.

GREENHOUSE

The greenhouse is a year-round tropical plant paradise and a site for controlled environmental research. Open daily until 3:30 p.m. with a free permit (see HOURS).

IES SEMINARS

Free **scientific seminars** are held at 11 a.m. on Fridays in the Auditorium. They are free, and reservations are not needed.
Sept. 28: **Direct and Indirect Effects of Tree Species on Forest Nitrogen Retention in the Catskill Mountains, N.Y.** Dr. Pamela Templer, Univ. of California, Berkeley
Oct. 5: **The Patuxnet River, Maryland: A Watershed Experiment in Nutrient Management.** Dr. Christopher F. D'Elia, SUNY Albany
Oct. 12: **Environmental Controls on Net Ecosystem-level Carbon Exchange and Productivity in a Central American Wet Tropical Forest.** Dr. Henry W. Loescher, Univ. of Florida
Oct. 19: **Bioavailability of Organic Matter in the San Francisco Bay Delta: Implications for Ecosystem Restoration.** Dr. William V. Sobczak, U.S. Geological Survey, Calif.
Oct. 26: **Plant Respiratory Responses to Environmental Variation as a Determining Factor in Ecosystem Carbon Cycling.** Dr. Kevin Griffin, Lamont-Doherty Earth Observatory, Columbia Univ., N.Y.
Nov. 2: **Trophic Interactions of a New Exotic Species, *Cercopagis pengoi*, in Lake Ontario.** Dr. Joseph Makarewicz, SUNY Brockport

ART EXHIBIT

ecollage³

Artwork by IES staff will be on display at the Plant Science Building through early November, and is open to the public Mon. - Fri. from 9 a.m. - 4 p.m. (closed public holidays). Admission is by free access permit from the Gifford House (see HOURS).

HOURS

Winter Hours: October 1 - March 30
Free permits are required; available at the Gifford House Visitor and Education Center until 3 p.m.
Public attractions: Mon. - Sat., 9 a.m.-4 p.m. and Sun. 1-4 p.m.; closed public holidays. The Greenhouse closes at 3:30 p.m. daily.
The Ecology Shop: Mon.- Fri., 11 a.m.-4 p.m., Sat. 9 a.m.-4 p.m., and Sun. 1-4 p.m.
(Please note: The shop is closed weekdays and Saturdays from 1-1:30 p.m.)

THE ECOLOGY SHOP

New in the Shop ... small windchimes ... decorative night-lights ... **for children** ... new Folkmanis® puppets ... **in the Garden Room** ... gardening gloves
Senior Citizens Days: 10% off on Wednesdays

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include subscription to the newsletter, member's rate for courses and excursions, a 10% discount on IES Ecology Shop purchases, and participation in a reciprocal admissions program. Individual membership: $40; family membership: $50. Call the Development Office at 845-677-7600 ext. 120.

The Institute's Aldo Leopold Society
In addition to receiving the benefits listed above, members of The Aldo Leopold Society are invited guests at spring and fall IES science updates. Call the Development Office at 845-677-7600 ext. 120.

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... IES website: www.ecostudies.org

For information on current IES public events and attractions, visit: www.ecostudies.org/welcome/ThisWeek.html.
For garden tips, follow the link to the Perennial Garden Archives.